



# 2014 Road Weather Management Stakeholder Meeting

Optional Training Session  
9:10 – 10:00



## Tools for Road Weather Management Benefit/Cost Analysis



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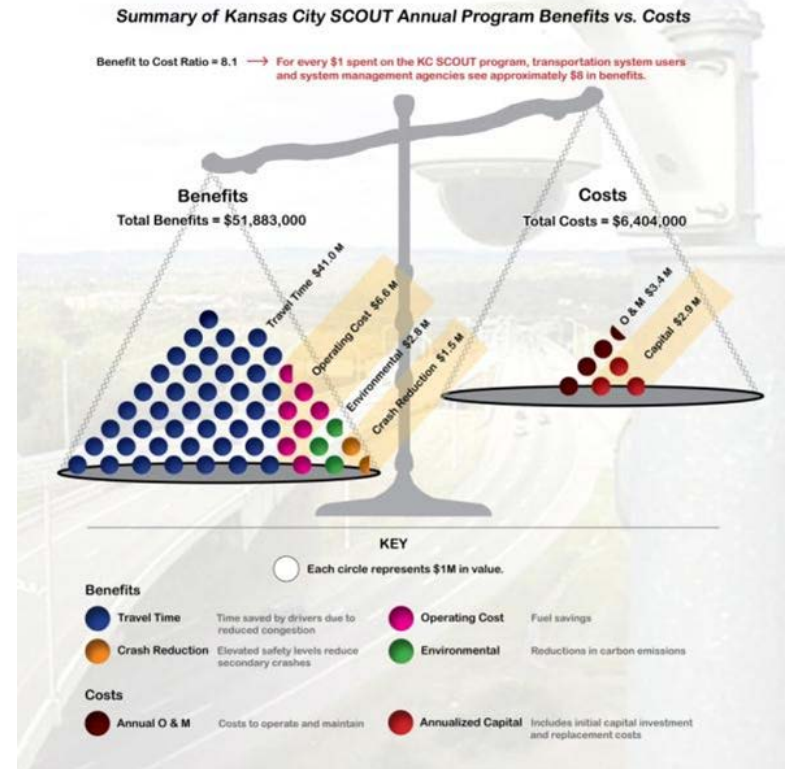
August 12 – 14, 2014  
Salt Lake City, Utah

# What I Will Cover in this Presentation

- Why is BCA Important for Transportation Operations/WRTM and What are the Challenges?
- Introduction to BCA
- Steps for Conducting BCA
- Measuring Costs and Quantifying WRTM Benefits
- Tools and Resources for Conducting WRTM BCA

# BCA for Transportation Operations Strategies

- It is often difficult for decisionmakers to weigh the benefits of investing in operations strategies vs. more traditional capacity projects
- Benefit/Cost Analysis helps decision makers consider the value of operations projects including WRTM



# Challenges for Transportation Operations BCA

- Estimating and quantifying the effects of strategies
  - e.g. traveler response to information?
- Including “non-typical” days in the analysis
- Measuring & Valuing travel time reliability
- Operations is often a collection of integrated elements (e.g. field, center, vehicle)
  - Not all physical (procedures)
  - Data sharing
  - Synergies
  - Cost attribution
- Operation and Maintenance Costs



# Specific Challenges for WRTM BCA

- Frequency, intensity and specific location of weather events are unknown/unpredictable
- Impacts of weather on traffic mobility and safety not well established
- Limited knowledge on the effectiveness of WRTM strategies in mitigating weather impacts

# Types of Economic Analysis



U.S. Department of Transportation  
Federal Highway Administration  
Federal Transit Administration

- Benefit Cost Analysis
  - Life-Cycle Cost Analysis
- Equity Analysis
- Financial Analysis
- Activity Forecasting
- Risk Analysis
- Economic Impact Analysis

# Steps for Conducting BCA

1. Establish objectives
2. Identify constraints and specify assumptions
3. Define base case and identify alternatives
4. Set analysis period
5. Define level of effort for screening alternatives
6. Analyze traffic effects
7. Estimate benefits and costs relative to base case
8. Evaluate risk
9. Compare net benefits and rank alternatives
10. Make recommendations

# Benefits & Costs – A List

- **Benefits**

- ✓ Reduced Congestion
- ✓ Travel Time
- ✓ Reliability
- ✓ Safety
- ✓ Energy
- ✓ Others

- **Costs**

- ✓ Equipment
- ✓ O&M
- ✓ Software
- ✓ Communications
- ✓ Installation
- ✓ Others

What's Missing?



# Cost Quantification

- Price lists
- Data such as FHWA ITS Cost Database  
[www.itscosts.its.dot.gov](http://www.itscosts.its.dot.gov)
  - Provides historic ITS deployment costs
  - Unit Costs, System costs
  - ITS Capital and O&M Cost
- Previous Projects

# Benefit Quantification

- Often the heart of the matter!
- Identify Measures of Effectiveness (MOE)
  - Traditional – Travel Time Savings, Vehicle Operating Cost, Safety, Emissions
  - Emerging MOEs – Travel Time Reliability, Induced Travel/Consumer Surplus, Climate Change
  - Other MOEs – Quality of Life, Customer Satisfaction, Feelings of Safety & Security

# Benefit Monetization

- Where we need to get to for BCA
- Pair MOEs with value estimates & prices
  - Value of time
  - Value of reliability
  - Value of life
  - Cost of injury and property damage
  - Fuel price
  - Value of emissions reductions
  - Others

# Data Requirements for WTRM BCA

- Traffic Data (Volume, Speed, Travel Time)
- Safety Data (Crash rates, Crash costs)
- Mobility Costs (Value of time/delay)
- Agency Costs (labor rate, material, equipment costs)
- Vehicle Operating Costs (fuel cost etc.)
- Discounting Rates (interest, inflation)

# Hierarchy of BCA Tools

- **General Tools**
  - **Various Spreadsheets**
- **Transportation Tools**
  - **bca.net**
- **Transportation Program Areas**
  - **IDAS, TOPS-BC**
- **Technology-Specific Tools**
  - **Clear Roads BCA Toolkit**



# WRTM BCA Resources - ITS Benefits Database



U.S. Department of Transportation  
Federal Highway Administration  
Federal Transit Administration

- [www.itsbenefits.its.dot.gov/](http://www.itsbenefits.its.dot.gov/)

The screenshot shows the ITS Benefits Database website. The header includes the RITA logo and the text "U.S. Department of Transportation Research and Innovative Technology Administration". Below the header is a navigation bar with "Intelligent Transportation Systems Joint Program Office" and icons for various transportation modes. The main content area is titled "Knowledge Resources" and includes a search bar, a list of resources (Home, Benefits Database, Costs Database, Lessons Learned, Applications Overview, Deployment Statistics, Contact Information), and a sidebar with "Benefits Database" links (Overview, About Benefits, Browse Benefits, Map Benefits, Latest Updates, Frequently Asked Questions, Available Documents, Links). The main content area displays "Road Weather Management (61 unique benefit summaries found)" and a list of related T3 Webinars, including "Indiana reduced their total winter maintenance budget by 27 percent for an estimated \$11 million savings by implementing a Maintenance Decision Support System (MDSS). (June 2012)".

**U.S. Department of Transportation**  
Research and Innovative Technology Administration

Intelligent Transportation Systems  
Joint Program Office

**Knowledge Resources**

Home Benefits Database Costs Database Lessons Learned Applications Overview Deployment Statistics Contact Information

Knowledge Resources Home > Benefits Database > Road Weather Management

**Search**

Enter Keyword

in Benefits

**Benefits Database**

Overview  
About Benefits  
Browse Benefits  
Map Benefits  
Latest Updates  
Frequently Asked Questions  
Available Documents  
Links

**Submit Your Data**

Please share any documentation

**Road Weather Management (61 unique benefit summaries found)**

**Related T3 Webinars**

Surveillance, Monitoring, & Prediction Traffic Control Response & Treatment Information Dissemination

- ▶ Indiana reduced their total winter maintenance budget by 27 percent for an estimated \$11 million savings by implementing a Maintenance Decision Support System (MDSS). (June 2012)
- ▶ Maintenance Decision Support System (MDSS) use shows benefit-cost ratios ranging from 1.33 to 8.67. (May 12, 2009)
- ▶ A modeling study compared the benefits of using road weather information systems (RWIS) with the costs of reacting to prevailing weather conditions and found that RWIS technologies could reduce snow and ice control costs by as much as 10 percent. (1991)

**Atmospheric Conditions**

- ▶ Weather Notification System issues on time alerts 88.9 percent of time, but message coverage remains incomplete. (August 2010)
- ▶ Rural Road Weather Information System deployments show estimated benefit-cost ratios of 2.8 to 7.0. (January 2010)
- ▶ Use of weather information shows benefit-cost ratios of 1.8 to 36.7, with winter maintenance costs reduced by \$272,000 to \$814,000. (April 2009)
- ▶ Utah DOT's Weather Operations/RWIS program provides a benefit-cost ratio of 11:1 from reduction in winter maintenance costs. (2008)
- ▶ A Maintenance Decision Support System (MDSS) used by MaineDOT aided maintenance crews by providing visual aids to track storms, recommending treatments, extending trend forecasts.

# WRTM BCA Resources - ITS Costs Database



U.S. Department of Transportation  
Federal Highway Administration  
Federal Transit Administration

- [www.itscosts.its.dot.gov/](http://www.itscosts.its.dot.gov/)

The screenshot displays the ITS Costs Database website. At the top, the RITA (Research and Innovative Technology Administration) logo is shown alongside the U.S. Department of Transportation. Below this, the 'Intelligent Transportation Systems Joint Program Office' banner is visible. A navigation bar includes links to 'Home', 'Benefits Database', 'Costs Database' (which is highlighted), 'Lessons Learned', 'Applications Overview', 'Deployment Statistics', and 'Contact Information'. A search bar on the left allows users to enter keywords and filter results by 'Costs'. The main content area is titled 'Road Weather Management (51 unique system cost summaries found)' and features a 'Related T3 Webinars' section with tabs for 'Surveillance, Monitoring, & Prediction', 'Traffic Control', 'Response & Treatment', and 'Information Dissemination'. A list of cost summaries is provided, including details on private sector data procurement costs, weather information integration into Transportation Management Centers, and the costs of various road weather information systems and equipment. A sidebar on the left contains a 'Costs Database' menu with options like 'Overview', 'About Costs', 'Browse Costs', 'Map Costs', 'Latest Updates', 'Frequently Asked Questions', 'Available Documents', 'Links', and 'Unit Costs' (with sub-options for 'Unadjusted Costs' and 'Adjusted Costs').

U.S. Department of Transportation  
Research and Innovative Technology Administration

Intelligent Transportation Systems  
Joint Program Office

Knowledge Resources

Home Benefits Database **Costs Database** Lessons Learned Applications Overview Deployment Statistics Contact Information

Knowledge Resources Home > Costs Database > Road Weather Management

**Search**

Enter Keyword

in Costs GO

**Costs Database**

- Overview
- About Costs
- Browse Costs
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- Latest Updates
- Frequently Asked Questions
- Available Documents
- Links
- Unit Costs**
  - Unadjusted Costs
  - Adjusted Costs

**Road Weather Management (51 unique system cost summaries found)**

▶ **Related T3 Webinars**

Surveillance, Monitoring, & Prediction Traffic Control Response & Treatment Information Dissemination

View Related Cost Data

- ▶ Study finds that costs of procuring private sector data to support WRTM can range from \$28,000 to \$200,000 per year. (October 18, 2012)
- ▶ Weather Information Integration into Transportation Management Center estimated at \$314,500, with \$49,500 in annual maintenance costs. (January 2011)
- ▶ In Nisqually Valley, Washington, an Ice Warning System consisting of a road weather information system (RWIS) station and closed-circuit television (CCTV) camera cost \$165,000. (June 2009)
- ▶ In Wenatchee, Washington, the construction of a Transportation Management Center (TMC) and the installation of the associated ITS field equipment cost \$460,000. (June 2009)
- ▶ In Yakima, Washington, the deployment of a Traveler Information System cost \$333,000. (June 2009)
- ▶ Statewide Implementation of a Maintenance Decision Support System (MDSS) in Indiana for FY09 cost \$529,000 (2009)

**Atmospheric Conditions**

- ▶ Study finds that bridge wind speed alerting system can cost as little as \$10,000 per site. (June 2012)
- ▶ Weather Information integration into TMC Operations estimated at \$6,270,000, with \$833,000 in annual Operations and Maintenance Cost. (December 15, 2010)

# Road Weather Management BCA Compendium



U.S. Department of Transportation  
Federal Highway Administration  
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- Several case studies being developed that describe BCAs for road weather management technologies or strategies
- Hypothetical examples demonstrate how TOPS-BC, Clear Roads & Other BCA tools can be used
- Shows how analysts have conducted or in the future could conduct a BCA for road weather management

ROAD WEATHER MANAGEMENT STRATEGIES	
Surveillance, Monitoring and Prediction	Traffic Control
Response and Treatment	Information Dissemination

# TOPS-BC: An Introduction

- TOPS-BC is a sketch planning Excel spreadsheet model designed to assist planners evaluate TSMO projects
- Designed for Visioning & Screening
- Also useful for some Long-Range Planning
- Not designed for more detailed BCA required in project development

# What Can You do With TOPS?

*What would you like to do today?*

INVESTIGATE  
POTENTIAL IMPACTS  
OF STRATEGIES

RESEARCH  
AVAILABLE ANALYSIS  
METHODS AND TOOLS

ESTIMATE  
LIFE-CYCLE  
COSTS

ESTIMATE  
BENEFITS  
AND CONDUCT  
B/C ANALYSIS

MORE  
INFO



# TOPS-BC Application

- Conduct simple sketch planning level B/C analysis for selected TSM&O strategies
  - Develop a set of input data for project type, facility type, number of lanes, analysis period
  - Use TOPS defaults for facility performance or use your own data (freeway link capacity, etc.)
  - Select MOE impact levels or use TOPS national level defaults (travel time savings, etc.)
  - Select values for key variables including; travel time, reliability, crash costs, etc.

# Multiple Strategies

- You can select multiple strategies
- You can select supporting strategies
- You select the timeframe for analysis
- You select the discount rate
- You can vary inputs to run sensitivities
- You see your results instantly

# See the Results Instantly

Choose the active strategies:

- ☒ Generic Link Analysis
- ☒ Signal Coordination: Central Control
- ☒ Ramp Metering: Preset Timing
- ☒ Traffic Incident Management
- ☒ Dynamic Message Sign
- ☒ Highway Advisory Radio
- ☒ Pre Trip Traveler Information
- ☒ HOT Lanes
- ☒ Hard Shoulder Running
- ☒ Speed Harmonization
- ☒ Road Weather Management
- ☒ Work Zone Systems
- ☒ Traffic Management Center
- ☒ Loop Detection
- ☒ CCTV

## Benefit/Cost Summary

### Annual Benefits

	Generic Link Analysis	Signal Coordination: Central Control
Travel Time	\$ 0	0
Travel Time Reliability	\$ 0	0
Energy	\$ 0	0
Safety	\$ 0	0
Other	\$ 0	0
User Entered	\$ 0	0
<b>Total Annual Benefits</b>	<b>\$ 0</b>	<b>0</b>

### Annual Costs

	\$ 0	0
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### Benefit/Cost Comparison

Net Benefit	\$ 0	0
Benefit Cost Ratio	0.00	0.00

### Stream of Net Benefits

# Clear Roads BCA

## Road Weather Strategies

- Anti-icing
- Deicing
- Carbide blades
- Front plows
- Underbody plows
- Zero velocity spreader
- Maintenance Decision Support Systems (MDSS)
- Automatic Vehicle Location and Geographic Positioning Systems (AVL/GPS)
- Road Weather Information Systems (RWIS)
- Mobile pavement or air/pavement temperature sensors

# Clear Roads BCA

## 5-Step Process

- Step 1: **Define Project Parameters** –the user will provides specific parameters related to the application they plan to analyze.
- Step 2: **Enter Costs** –the user enters initial and annual costs specific to the agency. Such costs include the purchase price of the item of interest, installation, maintenance, communications, and so forth
- Step 3: **Benefits** – This page presents the user with a list of quantified and nonquantified benefits that may be achieved by the agency, user and society through the use of the item being examined.
- Step 4: **Benefit Quantification** –the user enters values related to the determination of benefits that use an item will produce for the agency, user and society.
- Step 5: **Results** - the user will see the results of their analysis.



# Summary

- Tools are available for general Operations BCA as well as specific WRTM BCA
- Not a single analytical tool that can do everything or solve every problem
- Method or tool should be consistent with planning objectives and matched with budget and resource requirements
  - Using a tool that is too sophisticated results in poor use of resources
  - Using a tool that is too basic results in inaccurate or unreliable results

# Latest FHWA Materials to Support Planning for Operations

## Designing for Transportation Management and Operations A PRIMER



SPEED LIMIT 60  
SPEED LIMIT 50  
SPEED LIMIT 50  
SPEED LIMIT 50  
SPEED LIMIT 50

## OPERATIONS BENEFIT/COST ANALYSIS DESK REFERENCE

Providing Guidance to Practitioners in the Analysis of Benefits and Costs of Management and Operations Projects



FOR MORE INFORMATION  
CONTACT THE FHWA  
TECH OPERATIONS  
LAW OFFICE 9-30

## OPERATIONS BENEFIT/COST ANALYSIS TOPS-BC USER'S MANUAL

Providing Guidance to Practitioners in the Analysis of Benefits and Costs of Management and Operations Projects



2012-2013

# FHWA BCA of TSMO Support



- BCA Desk Reference & Other Pubs
- BCA Data & Tool Development
- BCA Workshops for SDOT, MPO, Others
- Technical Assistance
- For Info Contact Jim Hunt

# Clear Roads BCA Toolkit

## **DEICING BCA EXAMPLE**

# Getting Logged on to the BCA Toolkit

- Go to the following website: <http://clearroads.org/>
- On the left bar, click on “**Research Projects**,” then scroll down to “**Completed Projects**” and click on “**Cost-benefit Analysis Toolkit Phase II (June 2013)**”
- Scroll down to “**Final Deliverables**,”
- Click on “**Final Report**” to download the Final Report
- Click on “**Cost-Benefit**” to download the Toolkit User's Manual
- Click on “**Cost-Benefit Toolkit**”
- You are off and running!



# Selecting Your Technology



U.S. Department of Transportation  
Federal Highway Administration  
Federal Transit Administration



## Cost-Benefit Analysis Toolkit



Select the technology you are interested in.

After you conduct an assessment for your first technology, you will be given an option to save the results and compare them against other technologies.

### Practices

Anti-icing ⓘ

Deicing ⓘ



### Equipment

Carbide blades ⓘ

Front plows ⓘ

Underbody plows ⓘ

Zero velocity spreader ⓘ

### Operations

Maintenance Decision Support Systems (MDSS) ⓘ

Automatic Vehicle Location and Geographic Positioning Systems (AVL/GPS) ⓘ

Road Weather Information Systems (RWIS) ⓘ


Mobile pavement temperature sensors ⓘ

Mobile air/pavement temperature sensors ⓘ

# Entering Basic Run Data

Analyst Name:

Agency:

Date:  

Project Description:

Year represented in the analysis:

Discount rate:

Analysis period (years):

Number of equipped trucks:

Total trucks:

Number of facilities (sheds/garage) with brine making infrastructure:

Loaded labor cost per hour (shop rate):

Average labor hours per storm event per vehicle:

Average labor hours per storm to produce materials:

Annual hours per vehicle to maintain deicing-specific equipment:

Annual number of storm events:

Average deicer application rate (tons or gallons per lane mile):

Lane miles covered per storm (all trucks):



# Initial Cost Data Calculator

Initial Costs Worksheet - Deicing

Items	Unit rate (\$)	# of units	Unit	Amount (\$)	Notes
Deicing equipment - Material spreaders (spinner, gravity drop, etc.)	800	900	vehicles	720000	
Deicing equipment - Sprayers (liquid deicing)	0	900	vehicles	0	
Controller	2389	900	vehicles	2150100	
Infrastructure (brine making equipment if employing liquid deicing activities)	0	110	building	0	
Other 1 (define)	0	0		0	
Other 2 (define)	0	0		0	
<b>Total initial expenditure</b>				<b>2870100</b>	



# Annual Costs Calculator

Annual Costs Worksheet - Deicing

Items	Unit costs per year	# of units	Unit	Amount (\$)	Notes
Material costs (year)	20	251200	tons	73200	
Production costs (liquid deicers)	0	20	storms	0	
Equipment maintenance	214	900	vehicles	192780	
Brine plant maintenance	0	0	years	0	
Corrosion/environmental cost per ton	0	251200	tons	0	
Other1 (define)	0	0		0	
Other2 (define)	0	0			
Cost of Alternative					
Minus cost of sanding and gritting	0	1	years	0	
<b>Total Annual O&amp;M Costs</b>				<b>266070</b>	

# Agency Costs

## Agency Costs

Initial costs calculator



Initial Costs: \$

73347

Annual costs calculator



Annual operating/  
maintenance costs: \$

206070

## Other Costs

The literature does not include costs to users or society, but if you would like to include those, you can add them. *Note: Any cost information entered by the user is being done solely at their discretion and employs values that may be of an assumed form.*

Add Society Costs

Add User Costs

## Results

Annualized Costs: \$ 278513

Present Value: \$ 1942111

Annualized Costs per unit: \$ 307





# Lists of Benefits



## Cost Benefit Analysis Toolkit - Deicing

### Deicing



#### Step 3 of 5: Benefits

Research has identified the following potential benefits for MDSS. Those in **bold** are included as tangible benefits, while those in regular typeface are included as intangible.

#### Agency

Generally inexpensive

#### User (Motorists)

**Improved safety**  
**Reduced traffic delay**

#### Societal

None identified

# The User Benefits Worksheet



U.S. Department of Transportation  
Federal Highway Administration  
Federal Transit Administration

User Benefits Worksheet - Deicing

Items		Unit rate (\$)	# of units	Unit	Amount (\$)	Notes
Improved safety and mobility	1	4.5	12162720	Deicing Cost	54732240	
Other 1 (define)	1	0	0		0	
Other 2 (define)	1	0	0		0	
Total Annualized Benefit					54732240	



# Benefit Calculations



U.S. Department of Transportation  
Federal Highway Administration  
Federal Transit Administration

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## Benefit Calculations

### Agency Benefits

Annualized

Present Value

0

Annualized Benefit per Truck

0

### User (Motorist) Benefits

Annualized (click on field for calculator)

54732240

Present Value

384416351

Annualized Benefit per Truck

60814

### Society Benefits

Annualized

Present Value

0

Annualized Benefit per Truck

0

### Total Benefits

Annualized

54732240

Present Value

384416351

Annualized Benefit per Truck

60814

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## Benefit-Cost Ratio

Agency Benefits

0

Total Benefits

6.7



# Summary of Results



U.S. Department of Transportation  
Federal Highway Administration  
Federal Transit Administration

<b><i>Agency Costs - Initial</i></b>	<b>Iowa</b>
Material spreader (\$800)	\$720,000
Flow controller (\$2389)	\$2,150,100
<b><i>Agency Costs - Annual</i></b>	
Material costs (\$30/ton)	\$4,536,000
Production Costs (\$14.42)	\$0
Equipment maintenance (\$14.42)	\$192,780
Corrosion/environmental cost ton (\$0)	\$0
<b><i>Total Costs - Summary</i></b>	
Annualized cost	\$8,137,418
Present value	\$57,153,817
Present value	\$9,042
<b><i>User Benefits</i></b>	
General savings	\$0
<b><i>User Benefits</i></b>	
Crash and travel time savings	\$54,732,240
<b><i>Total Benefits - Summary</i></b>	
Annualized benefit	\$54,732,240
Present value	\$384,416,351
Annualized benefit/truck	\$60,814
<b><i>Cost-Benefit Ratios</i></b>	
Agency	0.0
Total	6.7

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